

Helmholtz Particle Physics Programme.

Joachim Mnich

R-ECFA Visit Germany
Bonn, May 9, 2014



Beschleuniger | Forschung mit Photonen | Teilchenphysik

Deutsches Elektronen-Synchrotron
Ein Forschungszentrum der Helmholtz-Gemeinschaft



Helmholtz Association

> 18 large research centres in Germany

> Structured in six research fields

- Aeronautics, Space and Transport
- Earth and Environment
- Energy
- Health
- Key Technologies
- Structure of Matter (→ Matter)



Budget (2013):

- 2.4 G€ institutional funding (90% federal, 10% local)
- 1.2 G€ Third-party funding



Particle Physics in Helmholtz

> Restructuring of research field for next funding period (2015 -19)

Structure of Matter 4 programmes:

- Particle Physics
- Astroparticle Physics
- Hadrons and Nuclei
- Photon, Nuclei, Ions

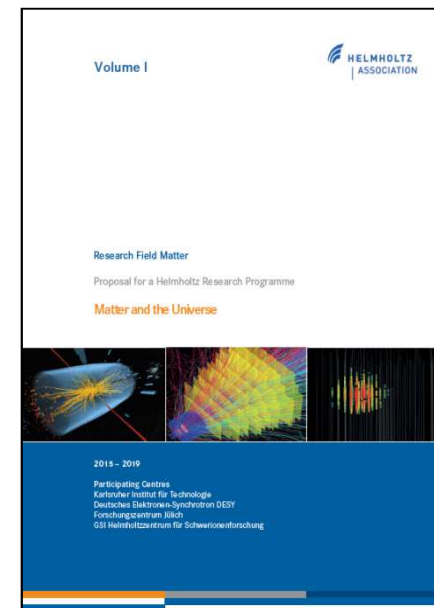


Matter 3 programmes:

- Matter and Universe
- From Matter to Materials and Life
- new** ▪ Matter and Technology
(Accelerator, Detector, Computing)

> Helmholtz Centres in (astro)-particle physics:

- **DESY**
- **KIT (Helmholtz part: computing and astro-particle physics)**
- **GSI (ALICE & FAIR)**
- **FZ Jülich (EDM experiment)**



DESY Long-term Strategy in Particle Physics



- > Accelerators
 - > Detectors
 - > Physics
- + support through strong theory group
- + computing infrastructure
- + testbeam & other infrastructures
- > Use of DESY infrastructure for particle physics
 - e.g. Tier-2/NAF, testbeam for detector R&D, ALPS II, ...
 - > **Strategic role of DESY as national laboratory for particle physics**

DESY at the LHC

> Two large groups in ATLAS and CMS

- more than 60 scientists per group

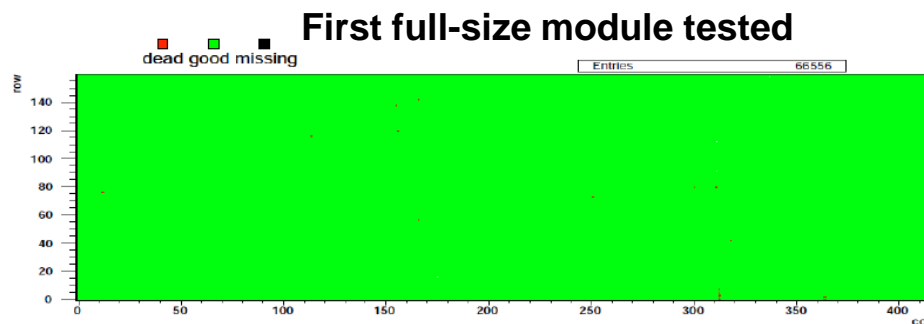
~1/3 staff, ~1/3 postdocs,
~1/3 students + technical support

> Building on large experience and expertise from HERA

- physics analysis, detector operation, computing, upgrades, management ...

> Example: CMS phase 1 pixel upgrade

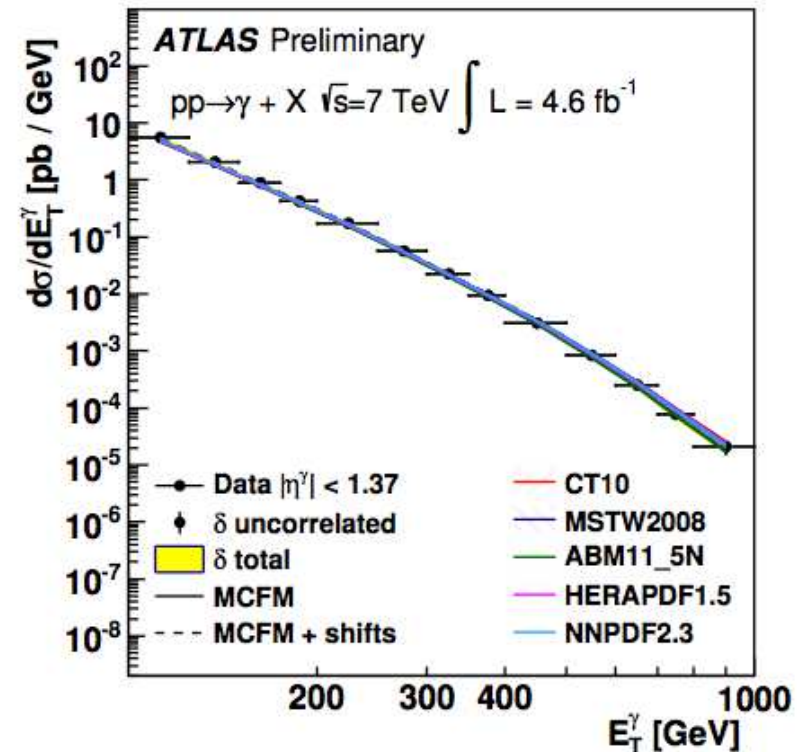
- 4th layer together with German CMS groups



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Example proton structure

- HERAFitter to extract PDFs



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LHC Detector Upgrades

- > Future: Phase 2 upgrades
- > Proposal for Helmholtz Strategic Large Investments

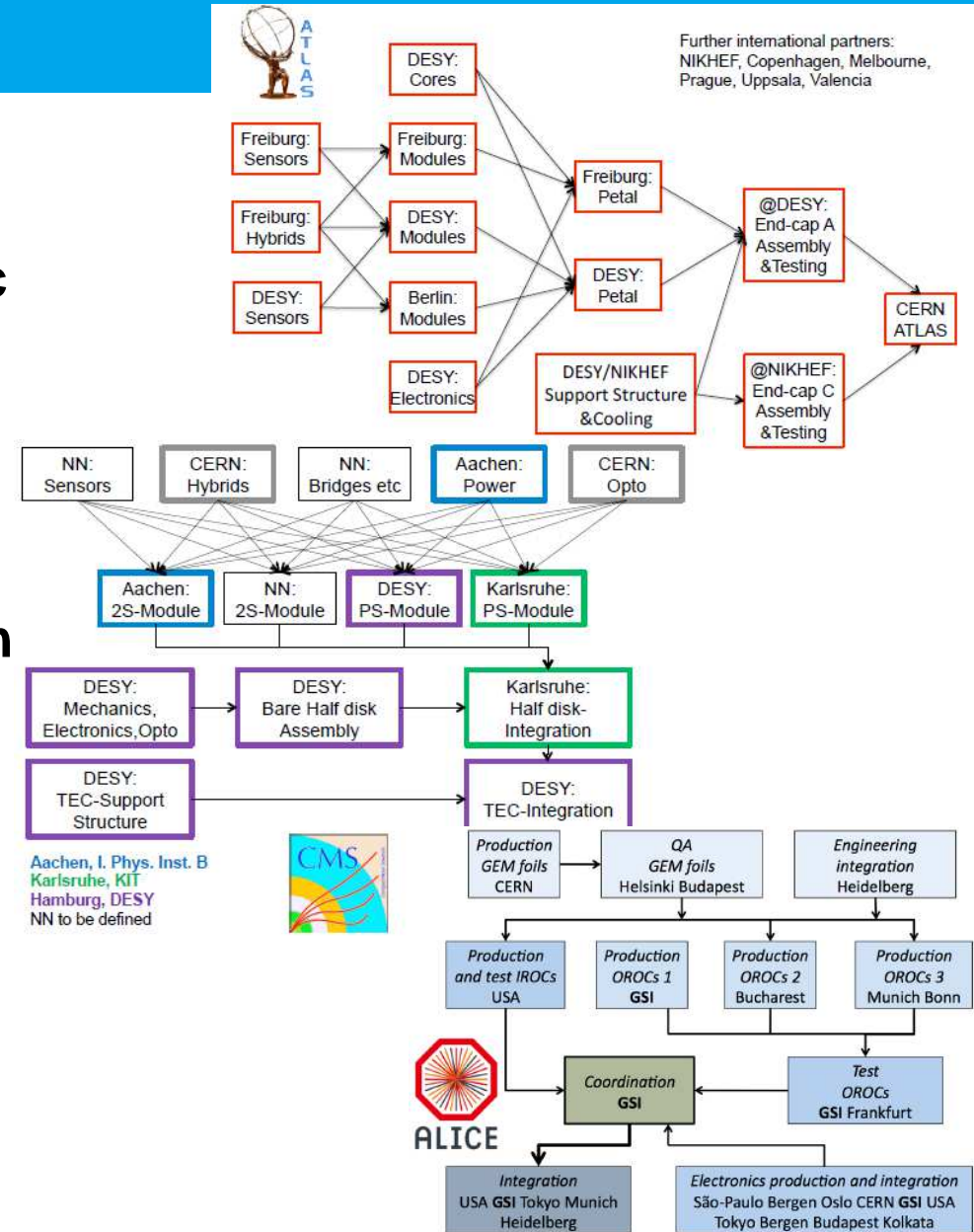
DESY, KIT, GSI: 28 M€

Helmholtz part for ATLAS & CMS tracker and ALICE TPC (2018)

- > Close collaboration with German & international partners

- part of German concept for LHC upgrade presented to funding agencies

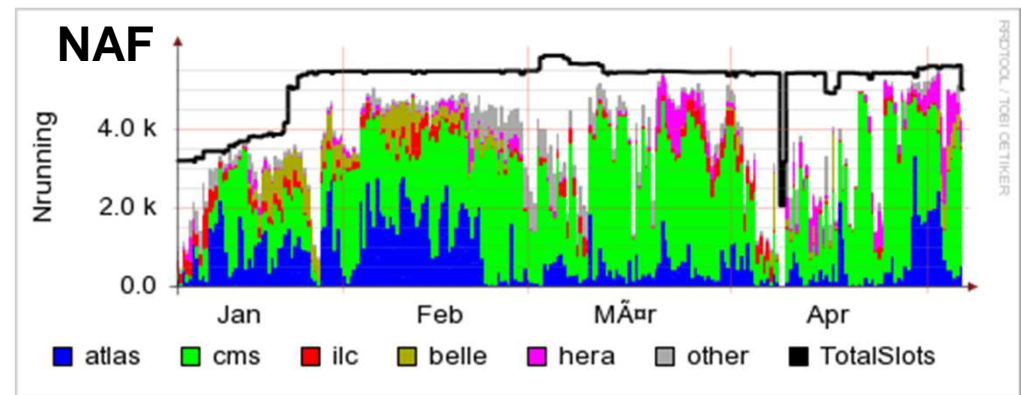
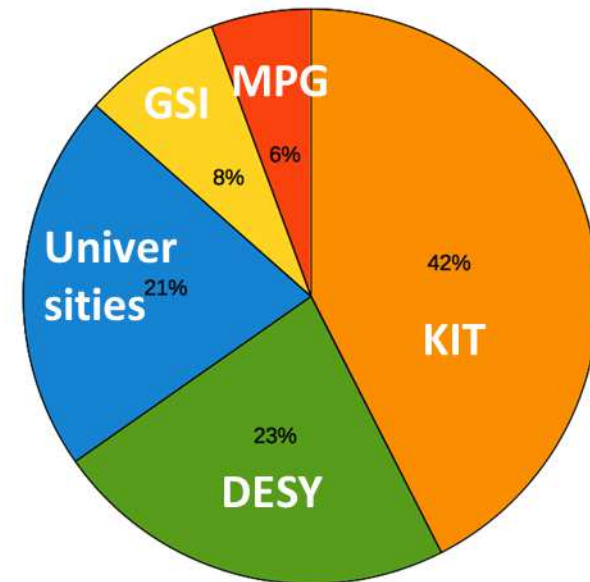
- > Crucial for future of particle physics in Helmholtz



Computing

- > **Helmholtz provides large share of LHC computing in Germany**
 - Tier-1 Centre at KIT (GridKa) for all experiments
 - Tier-2 centres at DESY (ATLAS, CMS, LHCb) and GSI (ALICE)
- > **National Analysis Facility (NAF) at DESY**
- > **Facilities used also for non-LHC experiments**
- > **Future:**
 - funding proposal to Helmholtz to secure Tier-1 and Helmholtz part of Tier-2 centres

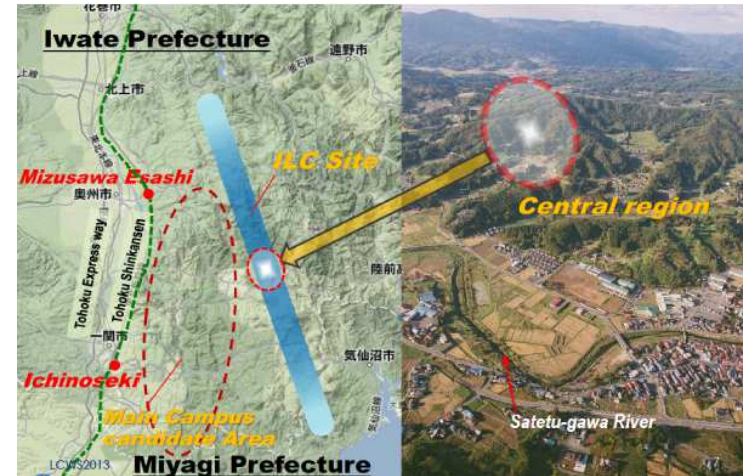
German Tier-1+2 CPU wall-clock time delivered



International Linear Collider

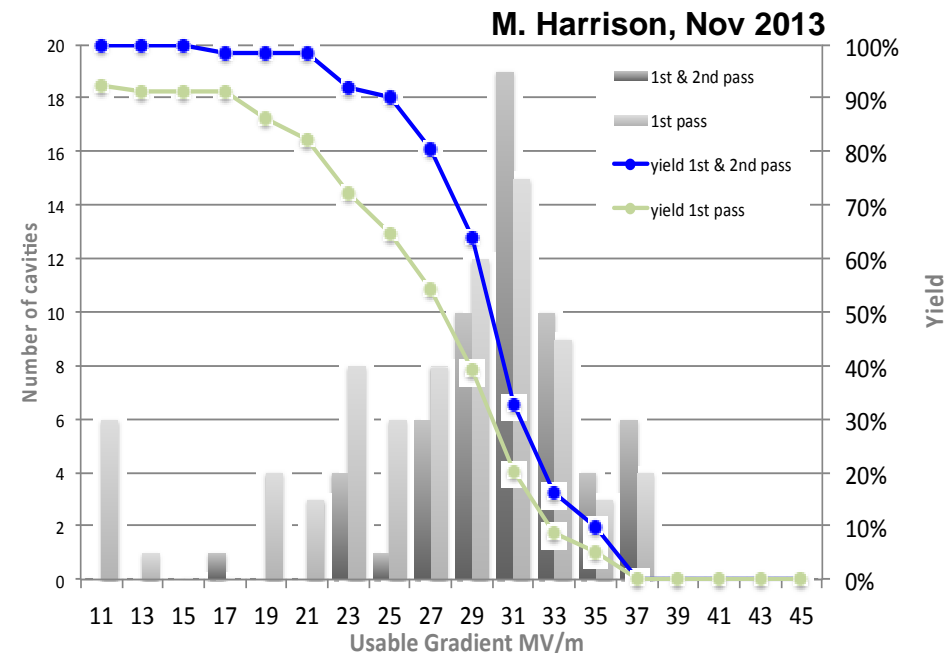
> DESY is key to the development of a superconducting linear collider

- TESLA collaboration since 1990ies
- key contributions to the 2013 ILCTDR
- construction of the European XFEL



> Example: industrial cavity production

- exceeds XFEL specs
- average gradient close to ILC needs (31.5 MV/m)
- plot based on 90 cavities, now 250 are tested



ILC Detector & Physics

> ILD and SiD detector concepts

- co-spokespersons in both concepts from DESY

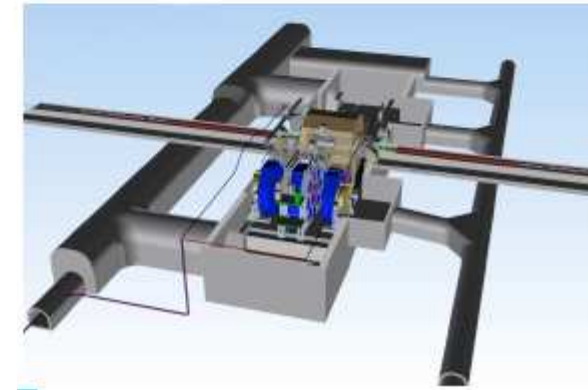
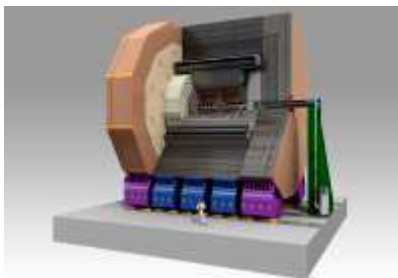
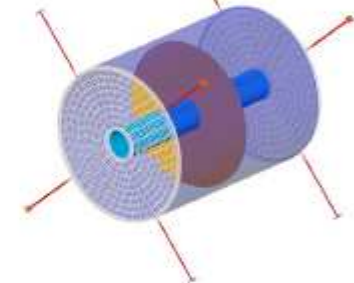
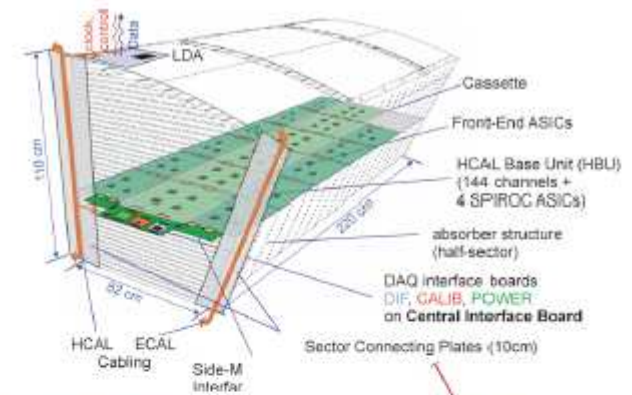
> Hadron calorimeter

- CALICE collaboration to advance Particle Flow algorithms

> TPC development

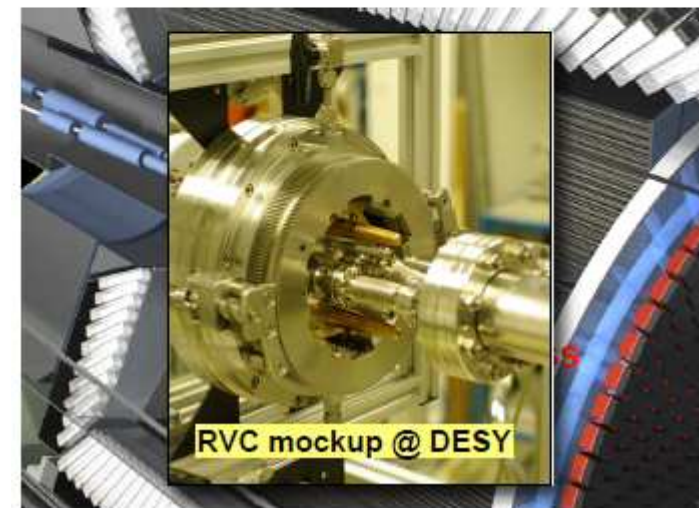
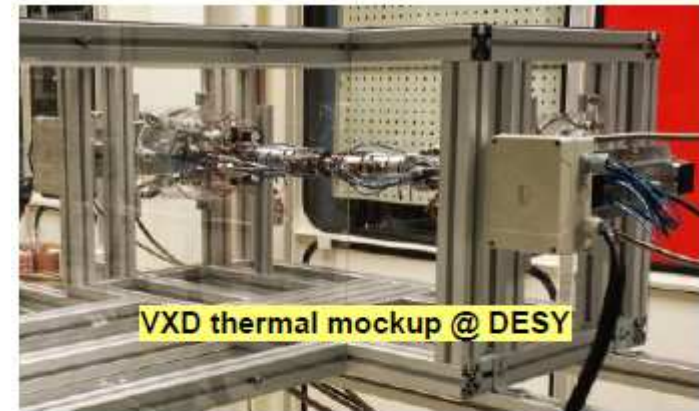
> Integration laboratory for detector

- engineering expertise and support
- EDMS for detector and accelerator



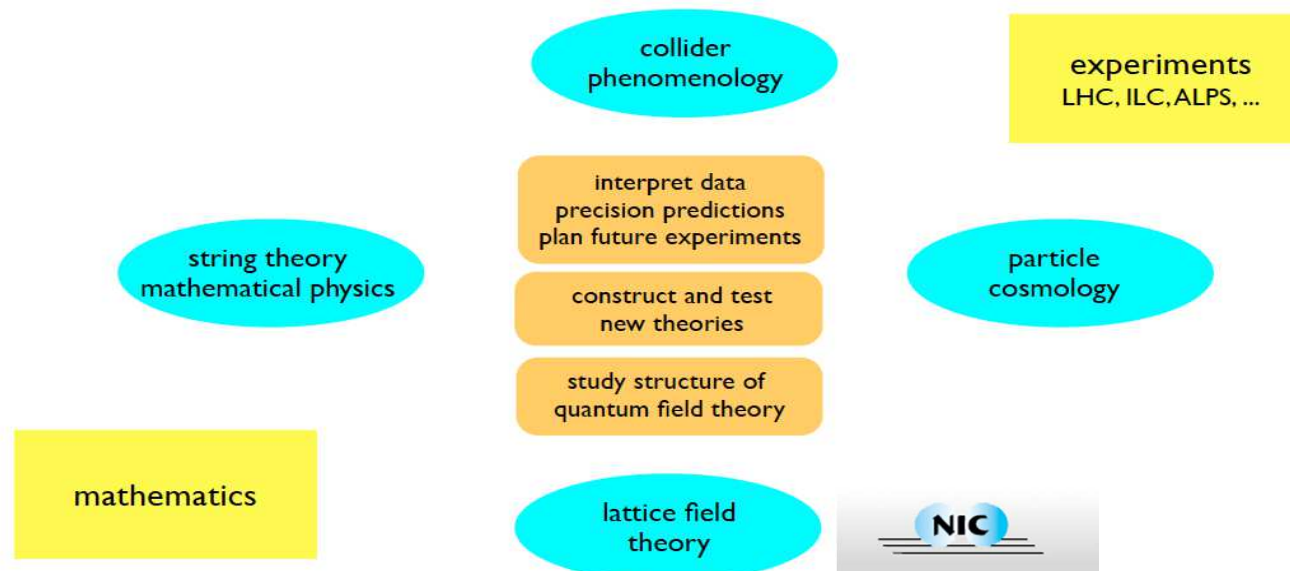
Belle (II)

- > **Germany plays major role in Belle II**
 - 10 institutes represent 2nd largest country after Japan
 - deliverable is DEPFET vertex detector in 2016
- > **DESY joined Belle II in 2011**
 - bringing in engineering expertise, e.g. heat management
 - delicate installation into Belle II (remote vacuum connection)
- > **DESY test Beam**
 - full vertex detector system test in Jan 2014
- > **Computing**
 - Tier-1 at KIT
 - Tier-2 & NAF at DESY



Particle Physics Theory in Helmholtz

- > **Broad spectrum, firmly connected to the experimental programme**



- > **Closely integrated with local universities (Hamburg, Berlin, Karlsruhe)**
- > **Shapes theoretical particle physics in Germany & beyond**

Lectures, schools, conferences, workshops

DESY fellowship programme (each year >300 applications from around the globe)

Large fraction of theory staff in Germany have a DESY history

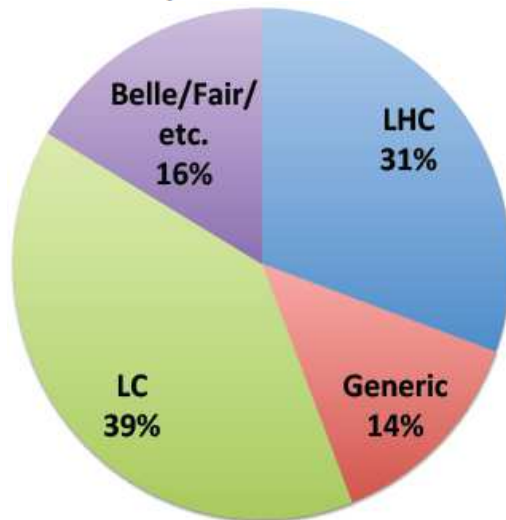


DESY Testbeam

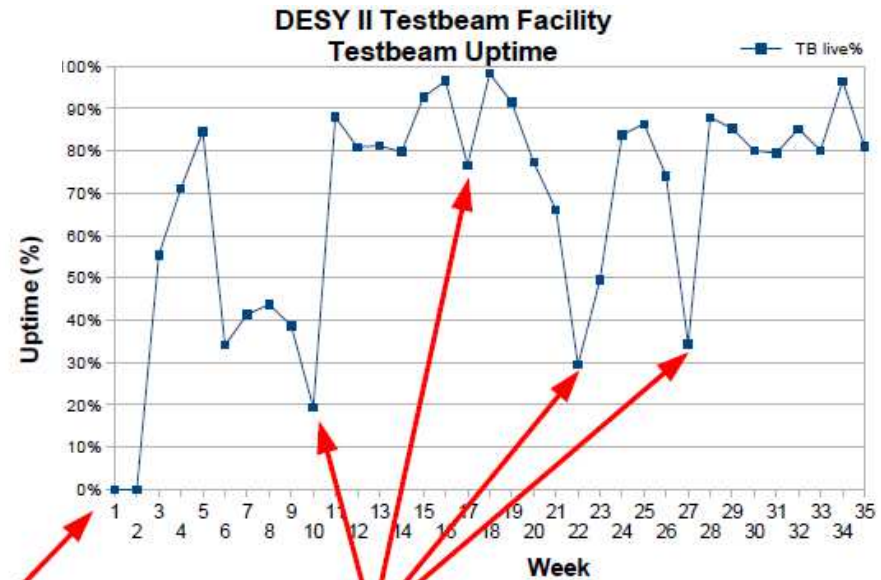
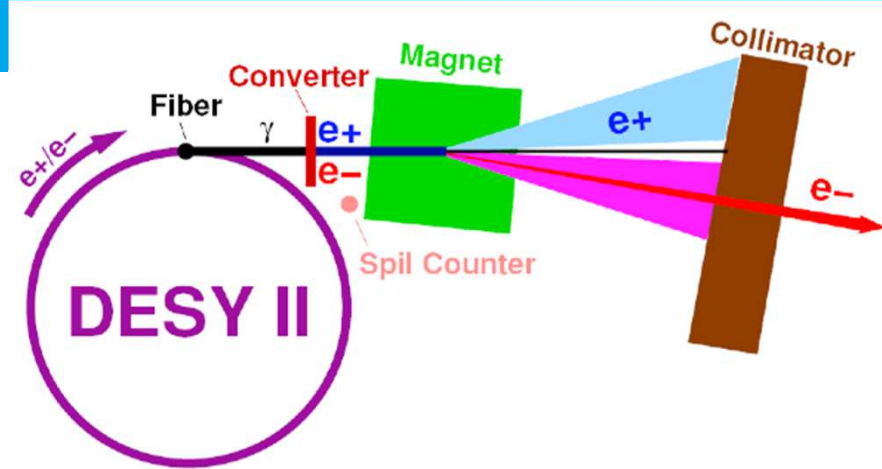
> Increasingly important facility for detector R&D

- approx. 400 users in 2013

- German groups : 24.7 %
- European groups : 50.2 %
- Extra-European users : 25.1 %



User groups represent all HEP communities.



Ramp-Up

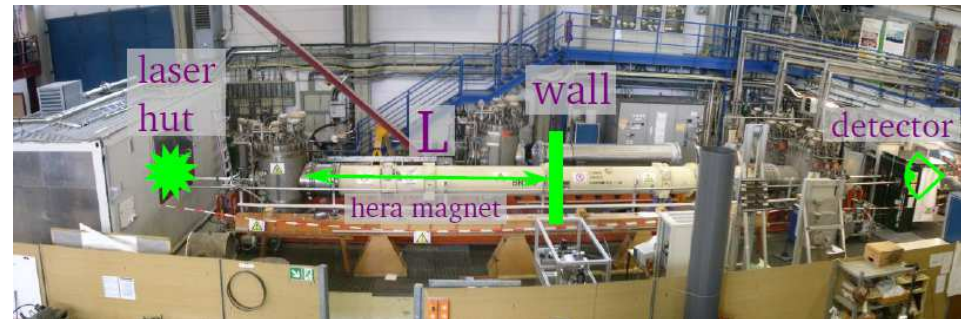
Maintenance weeks



Axion-Like Particle Search

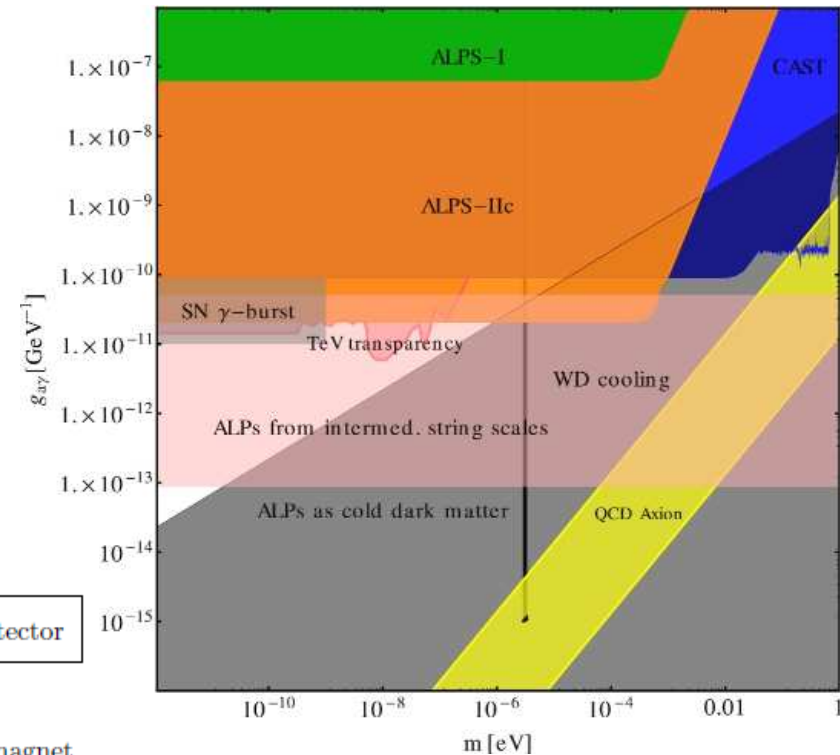
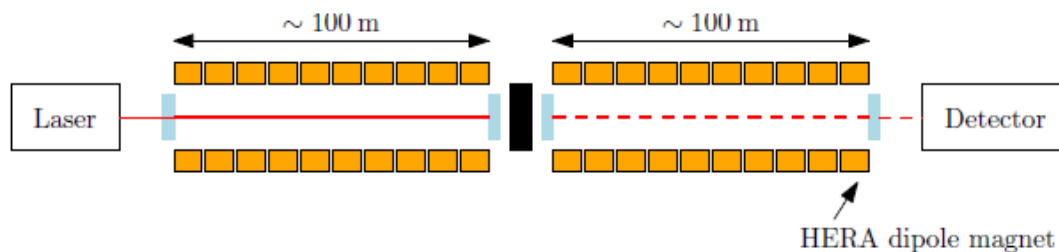
> ALPS I experiment:

- „light shining through wall“ experiment
- published results early 2010
- to-date still best limit (from this type of experiment)



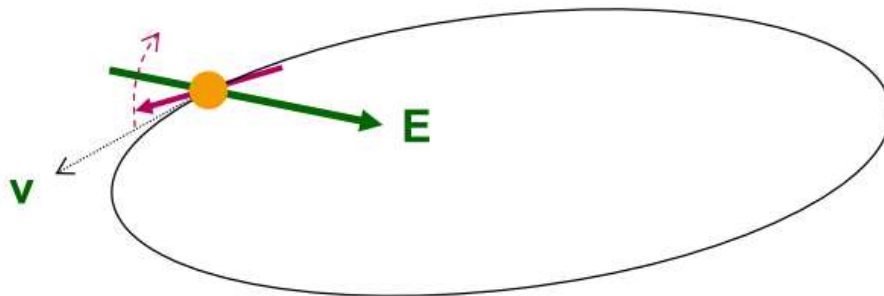
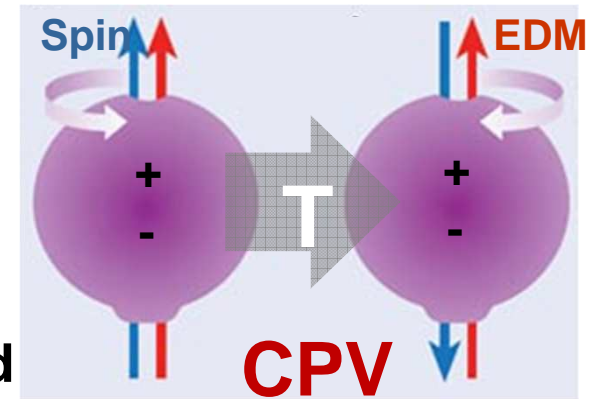
> ALPS II

- regeneration cavity
- transition edge sensor
- 2 × 10 straightened (!) HERA dipoles
- data taking expected in 2017



EDM Project at FZ Jülich

- > Electric Dipole Moment (EDM) sensitive to CP-violation beyond SM
- > New approach: EDM of charged particle
 - polarized (p,d) beam in storage ring
- > Sensitivity goal 10^{-29} e cm
 - wrt. nEDM: $< 10^{-26}$ e cm (goal 10^{-28} e cm)
- > Spin rotation due to torque in radial electric field



$$\frac{d\vec{s}}{dt} = \vec{d} \times \vec{E}$$

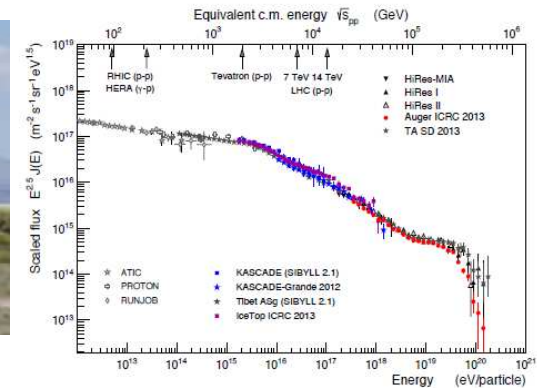
↑
EDM

- > COSY at Forschungszentrum Jülich
 - staged approach (during next 5 years)
 - precursor experiment at COSY (goal 10^{-24} e cm)
 - design of designated EDM ring

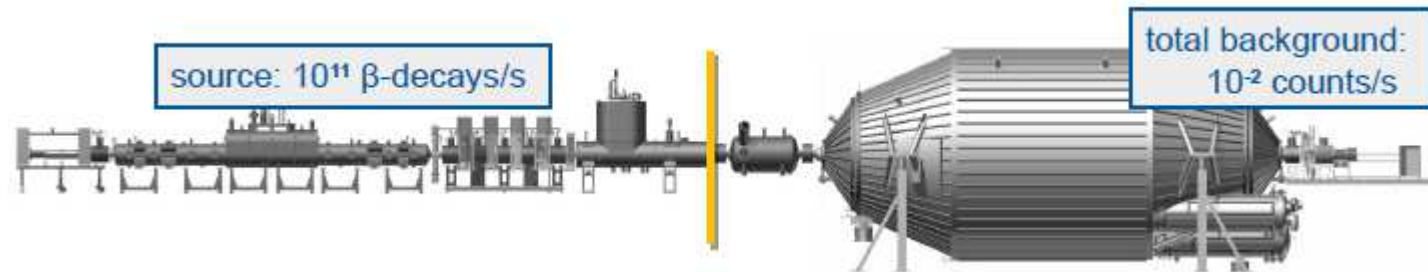
Astroparticle Physics in Helmholtz: KIT

> AUGER:

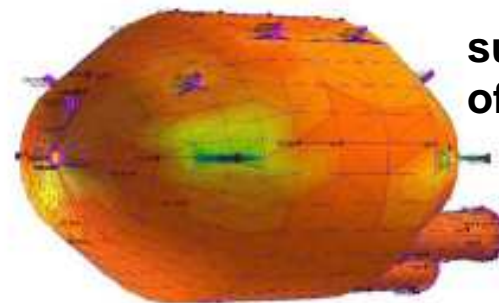
- KIT is the leading institute in Germany
- > 40 scientists & PhD students
- strong role in detector upgrades



> KATRIN:



- measure absolute neutrino mass scale with a sensitivity of 0.2 eV
- over 5 years (2016 - 21)



successful bake-out of spectrometer



Astroparticle Physics in Helmholtz: DESY

> IceCube

- **DESY is second largest group in the collaboration**
- **Tier-1 data centre**

> Upgrade plans for IceCube:

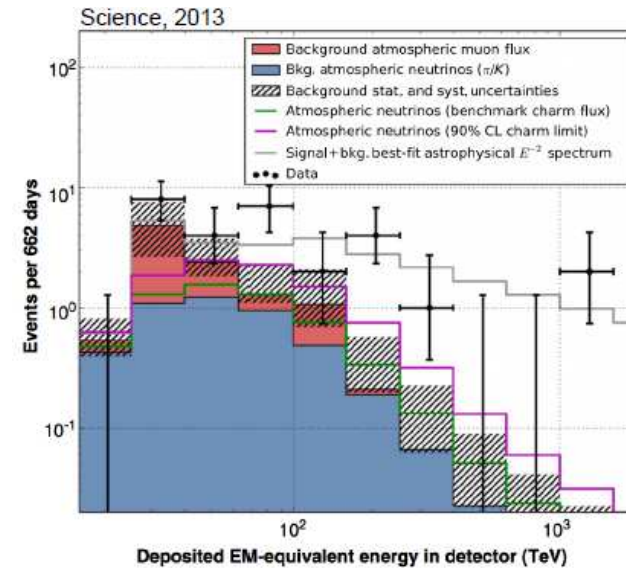
- **PINGU (neutrino mass hierarchy)**
- **multi-km³ neutrino telescope, multi-km² surface detector, ...**

> CTA

- **mid-size telescopes**
- **array control**
- **MC production**
- ...

> Participation in HESS, MAGIC, Veritas

Observation of extraterrestrial neutrinos



Telescope prototype close to Zeuthen



Helmholtz Alliance „Physics at the Terascale“

- > **Network between Helmholtz centres, universities and Max-Planck institute**
- > **Generously funded by Helmholtz**
 - 25 M€ for 2007-12 and 1 M€ for 2013-14
- > **Alliance very successfully contributed to shape German particle physics**
 - ≈1000 people, >150 events
 - numerous positions created in the field
- > **Future**
 - keep structures and main elements schools and workshops
 - with support from DESY and Universities
- > **Similar Alliances exist in hadron & nuclei and astroparticle physics**
 - Common events?



Summary

- > **Helmholtz centres important partners in German & international particle physics**
 - close collaboration with German universities and Max-Planck institutes
 - 5 years plan submitted and evaluated

- > **Proposal for investment funds (LHC upgrade + computing) in preparation**

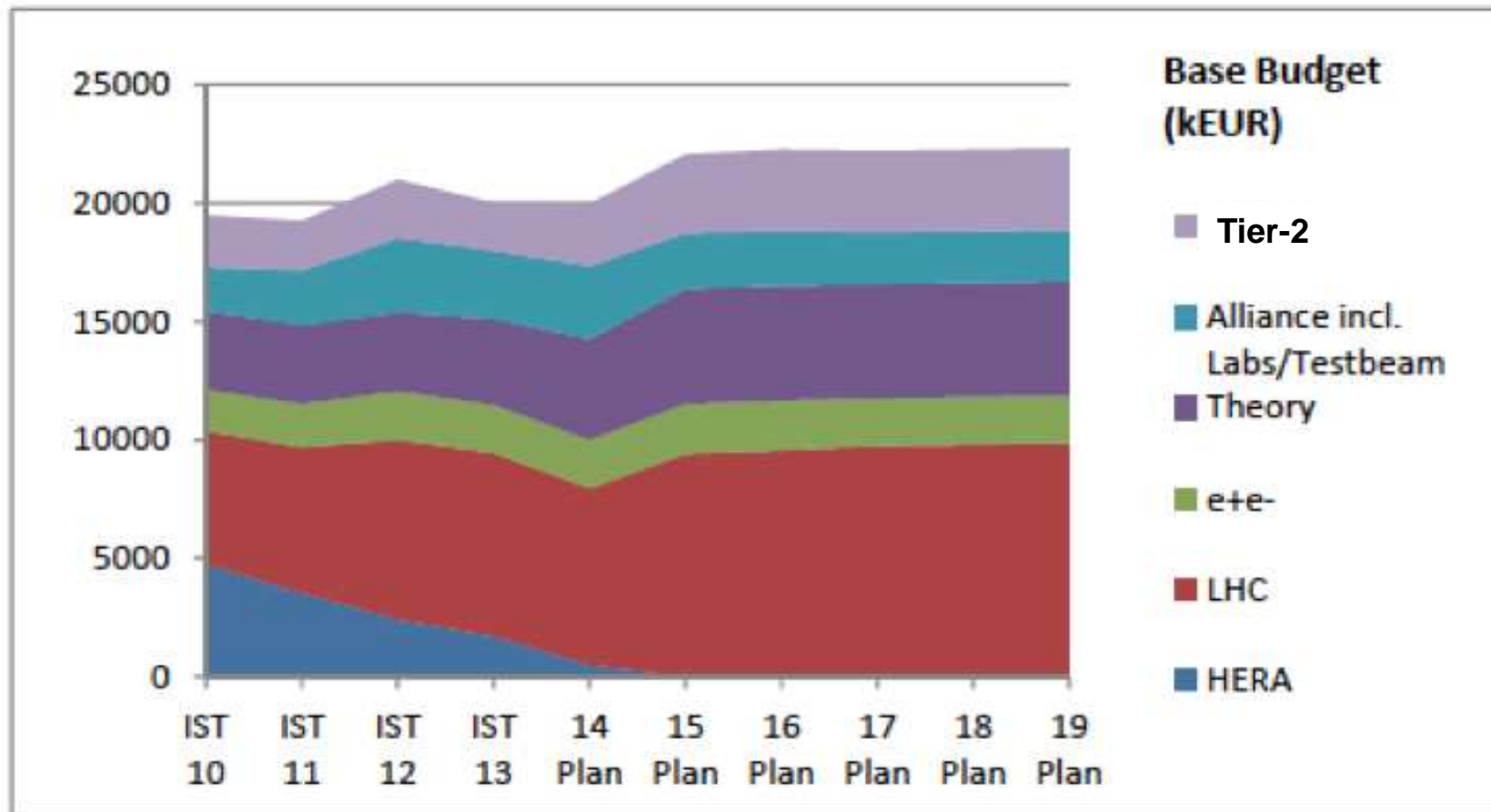
- > **DESY:**
 - successful evolution from laboratory with large on-site particle physics accelerator & experiments (HERA)
 - to key partner in international collaborations (LHC, ILC, Belle)



Backup



FUNDING DESY Particle Physics: Present & Future



PERSONNEL DESY Particle Physics: Present & Future

